SMALL-COMMERCIAL WOODCHIP COMBUSTION TECHNOLOGY

WORKSHOP

CHARLOTTETOWN, P.E.I.

CANADA

May 25, 26, 27, 1987

Sponsored by Energy, Mines and Resources Canada

SUMMARY

The first day of the workshop (May 25th, 1987) was taken up by a van tour of ten possible test sites in the Montague and Charlottetown areas which were described in the information package sent out to all invited participants. That evening there were presentations by Tony Short, Charles LeMay, John Kipping and Dave Murray. The second day began with presentations by Nazmir Bundalli, Erik Gunnarsson, Bjorn Janssen and Goran Standigh.

The participants then turned to discussing each of the sites which had been visited. Discussions were often vigorous and protracted. A number of important issues emerged repeatedly during the discussions. One of the most important is the lack of a fuel supply infrastructure and delivery equipment for small commercial systems. Many system options are restricted or precluded by this technological gap.

There was a general consensus that a good variety of small commercial woodchip technologies should be tested and demonstrated on P.E.I. and elsewhere. There seemed to be confidence that many of the technologies proposed have the potential to make conversions technically and economically viable in a wide range of small commercial businesses and institutions.

The workshop concluded on the afternoon of May 27, 1987.

The transcript of the workshop discussions has been edited to produce the attached synopsis. Wordings have been changed on occasion to clarify what was said and reduce the overall volume of the synopsis, but every attempt was made to retain the original intent of participants.

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4 Richardson Associates Ltd. P.O. Box 1057
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5 Mr. Fahti Shalabi Shalabi Technical Services
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6 Mr. Dave Murray Crowfield Associates Ltd.
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8 Mr. Jack Kelly Bulk Carriers Ltd.
Cornwall Prince Edward Island
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9 Mr. Robert Linkletter Linkletter Welding
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10 Mr. Vince Court Grovewood Heating
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C0A 1P0 Mr. Court

11 Mr. Eldon King Eastern Conservation Ind. Ltd.
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12 Mr. Ulrich Gallant Coop Forestiere
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Monday, May 25

Ian Flann: Welcome Ladies and Gentlemen. The first person on the program is Professor Tony Short.

Tony Short

Thanks very much, Ian. What I want to do this evening is share with you some of the work that I have been doing with Marc Schneider at U.N.B. since late 1978. The installation that we started off with was a Swedish Skogma Stoker and a CTC boiler. For a residential installation, this sort of system worked just fine for the first year or so, but the novelty wore off.

We found quite an accumulation of soot and carry-over of particles in the boiler. Based on advice from some people at the University of Maine who were working on the same problem, we tried building a refractory combustion chamber within the boiler to try and get a hotter environment in which the combustion gases would be retained for a period to force carry-over particles to burn to completion. The net result was worthwhile because we were able to get a much hotter combustion chamber and the smoke number that had been running around 6,7,8, dropped to something in the order of 1,2,3. We also found that the heat exchange surfaces stayed much cleaner.

Some of the things that went wrong: One long weekend, after I had complete confidence in the system, and went away and left it to run by itself, we had a panic phone call from the neighbor. The stoker had gone out but the auger kept running. It pushed itself out of the boiler and was moored to it only by the electrical umbilical cord. Restraining arms were added as a consequence of that particular episode, and it also led to their inclusion in the CSA code. Summertime efficiencies were roughly 30%. As you get into the winter season and the load increases, the overall efficiency rose to the high 40's, low 50% range. So, it is important to make sure that the heating unit is well matched to the load. If the heating unit is vastly over-sized, you are going to wind up with low efficiencies. Fuel consumption for a year was measured at about 11 tonnes of woodchips at 20% moisture content.

As part of a CREDA project that Marc Schneider, John Kipping, Jeremy Ricards, and I had going a few years back, a bin was built to demonstrate loading of chips into an above-ground bin. Wanson Hemphill came across with his chip truck. It took a couple of his truck loads to fill the bin. Once the chips were flowing, I think it took something like half an hour to unload 700 cu. ft. of chips. We were moving things quite quickly once we were set up. Getting things set up was time consuming.

A Heat Harvester from the U.S. replaced the Skogma about two years ago. It turned out that the automatic ash removal system simply did not work. After about 14 to 16 days, the combustion chamber plugged with ash. The flights of the feed auger stopped a few inches short of where they should have, and as a consequence of the jamming that developed, the drive motor that turned the entire assembly suffered two failures. In both cases, the teeth simply broke off the reduction gear on the motor. Also, the fuel simply would not feed out of the hopper of this $7,500 machine.

Bridging was another problem, so we had to finish the manufacturer's job for him, by adding stirrer shafts and arranging a drive for them and that seemed to cure the problem. Another problem of a general nature relates to the weight of the flights, far too thin. Agricultural grade flights simply will not do the job. The heavier flights, up to 3/8 " thick, seem to be necessary.

Combustion chamber. No attention whatsoever was paid to thermal expansion, and as a consequence when this chamber expanded diametrically at the point where it passes through a 1/4" thick stainless steel plate which resisted expansion, a large circumferential crack developed all the way around the periphery of the combustion chamber. Longitudinal expansion similarly was not accounted for. The cracks in the fire chamber made it impossible to control over-fire and under-fire air and it was very difficult to regulate the heat output.

Last summer we had some experience with a Vallsta Stoker for a two or three-month period. We tried sawdust in it but the combustion fan blew the sawdust off the grate. Some problems were also experienced with the European electrics being incompatible with our power supply.

Another project was the installation of an American AES furnace in John Kipping's house. An in-ground bin was constructed so delivery was very quick and easy, using conventional dump trucks. Getting the chips from the bin to the burner became a manual job involving garbage cans. The entire appliance is configured as a hot air furnace, rated by the manufacturer, probably a bit optimistically, at about 80,000 BTU per hour. We were running at about half of that.

In the fuel supply we had some long stringy pieces: pin chips as I think they are often referred to. These caused quite a few problems with this particular appliance. A second problem related to fouling of the heat exchanger. Fly ash carried up through the fire tubes would simply deposit on the top of the exchanger and block off various of the tubes. So, things need to be done to improve appliance design.

The inclined auger gave us some problems. The first motor lasted for something like five months before a bearing seized and essentially stopped the appliance. The new motor installed lasted about one month before exactly the same problem occurred. Having had two motor failures, they decided to put in something far more robust, so they put in a 1/15th h.p. motor and increased the rpm from 12 to 28. Limited testing indicates that it works all right. The shaft that drives the sprocket that draws chips out of the fuel hopper had some overload. A half-inch shaft was simply inadequate to carry the loads involved. Conclusion: For most of this equipment it takes months before some of the system problems show up and you are able to identify what the cause is and what a possible solution might be. Secondly, fuel quality with the small appliances is very important.

In order to reduce the manual labor, we devised a chip conveyor system. In the above-ground bin, the requirement was to move chips without manual shovelling. The decision was taken to try scraping the chips off the top of the pile. In order to do that a very slack loop of chain was arranged to run over the chips. The chain runs up over horizontal supports, down over a drive pulley, which is

putting the chain in tension. The chain falls off the drive sprockets onto the chips and is dragged over the pile down to the floor of the bin near the discharge end. At the discharge end an auger has been installed. This auger is a flexible auger of the type marketed by agricultural suppliers, made by Choretime. We took the largest available Choretime conduit, a 5" ID pipe, and placed in that something like a 2-3/4" OD flexible auger. This turns at about 350 rpm and is used to convey the chips a distance of about 4' out of the bin, through a 90° bend (about a 5' radius of curvature), and up an incline of around 70° for a further couple of feet. So, we are starting off at the floor, sweeping upwards and dumping chips into the top of a hopper that is about six feet off the ground. Experience has been that the flexible auger starts and stops when full or empty, but is susceptible to over-loading. The scraper chain systems appear to work based on limited testing to date. The scrapers fall down on the chip pile. They simply plane over the pile, drag chips down to the conveyor, dump their load, then rise back up, come back over the top and just keep on moving. The system operation is automatic. Level controls on the stoker control the flexible auger and a second the scraper chain. One of the potential advantages of this system is its flexibility in that it could be fitted to quite a range of sizes, of lengths, of widths of bin. I do not want to brag too much about the system yet though because I really have not made it operate under unattended operation for long periods of time, but still, it seems to work.

The Tilley Burner

At Ian Flann's request I went to have a look at the Tilley burner. It is built by a chap called Herb Goodine and his son Kevin in Tilley, New Brunswick. There are at least two hundred models out, each slightly different from its predecessor, employing a gravity feed hopper. They have a new stoker which has a photo cell that looks right down through the fuel hopper and sees the grate. The combustion is controlled strictly by the air damper. A little blower is used only for cooling the walls of the combustion chamber. Presumably temperatures were too high on the steel walls of the combustion chamber without it. On the little lid on top of the fuel hopper there is a pressure switch used to turn the fuel feed auger off after the hopper has been filled. A unique feature of this machine is the grate shaker. A couple of solenoids on a timer shake the grate about once a minute. They are quite noisy. The unit none the less is considered safe and ULC is pleased with it.

The front door can be swung open to remove ash from under the grate. It is a very quick operation. The Goodines are very interested in offering it as a retrofit. I think that the majority of the 200 sold have been of the retrofit version. None of them is CSA approved, but apparently the customers are very pleased with them. They are interested in finding someone, perhaps an existing manufacturer, who would be interested in picking up the design given that it has been developed to this extent and also that it has received ULC approval. They were intended for sawdust; apparently it also works quite well with chips.

There are three grades of fuel for which it has been tested and approved including chips. The unit that has been approved is the smallest of the range. It is about 175,000 BTU per hour. I would question that number actually, but that is what they are calling it. The stoker costs $4,200 in the hot air version. The prices go up from there, plus taxes.

Now the intent in showing you these slides was just to make you aware that this is the first ULC approved small-scale particulate wood burner in the Maritime provinces.

Bruce: It is in fact the only one being manufactured currently.

Tony: Now this is a little footnote. The thing that drove Bill Dykeman, the manufacturer of the Fire Fly and Saturn burner, to abandon this sort of product was the unavailability of, if not the cost of, manufacturers liability insurance. I raised that issue with the two fellows building this unit and their response suggested to me that they had never heard the words "manufacturers liability insurance".

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Ian Flann: Very interesting presentation, Tony, and I thank you for it. I would now like to introduce Charles LeMay who comes from Clarence Creek near Ottawa.

Charles LeMay

This is the third year we have been testing chip and sawdust burners but slowly it is becoming clear that there is quite a future for them in the Ottawa area. We can look at the forests down here and our forests in Ontario and they are quite similar. We cannot find very large trees anymore, so there is a lot of clean-up to be done and I think it is really worthwhile chipping junkwood and residue. Huge volumes of sawdust are available. The first two years the Eshland boiler was in a bungalow; this year it is heating water for a fish farm, and we find it quite adequate for that purpose if it is used with the proper fuels. The Eshland was working real fine on large chips. This year, we have experimented with sawdust in the TP2000 50 kw model. It is a mechanically simple appliance and, in fact, I think the farmer who is using it right now could replace any part quite easily. It took a full day to have it changed over to single-phase, 220 volts. The importer now supplies the unit ready to be plugged into a 110 V. outlet. The TP 2000 has a bin with a large wheel, a whip, and an auger on one side. It comes in two models. The 30 kW model simply has a tube in cast steel, and it burns right at the end of the tube with combustion air being forced into the chip combustion area through holes in the cast steel burner head. The 50 kW model has a rectangular burner pot with moveable grates. We found that the power output was grossly under-estimated if used with dry hardwood chips.

QUESTION: What moisture content are your chips?

The chips had been stock-piled outside, but after being left inside in bags like Tony does, they had dried down to about 33% wet basis. We operated the TP 2000 with a number of fuels. The pulp chips we used at first did a splendid job; no

bridging; everything fell neatly down to the bottom. However, a considerable volume of chips was left in the corners which are untouched by the rotating whip. We are going to use a flexible laminate to make the hopper cylindrical and so avoid this problem. If, when everything was shut down tight, all the seams were caulked with proper caulking, then we did not get any burn back. But, if that was not done, if it was just bolted together and left there, we did get some burn back on very dry fuels. We operated with different mixtures of sawdust. Any mixture containing sawdust gave us bridging. We went up to 75% chips, 25% sawdust, and that gave us bridging. We had better performance with fresh sawdust. One of the things we did notice was that the fans were blowing sawdust off the end and we were getting unburnt sawdust at the bottom of the fire chamber. So, sawdust is a problem and it is also a problem in the Eshland. I think each appliance needs to be evaluated for the type of fuel it can burn.

One thing this appliance does not have, and I think all should, is something to stop the stoker if the fire is extinguished. I can just see myself walking away from that appliance for a weekend, the fire going out and just having a continuous feed of chips in there. The auger is so powerful on these, so low-geared, that it would most probably pop everything off, no matter what was holding it -- you know, something would have to give. So, I would think that a stoker cutoff would be necessary on any of these appliances.

We had a number of problems with noise level. The first one was the relay on this appliance. It gave a powerful bang and this happened in the middle of the night a few times. The homeowner said you will have to do something about that because I hate being awakened by a bang like that. The other thing is the grinding of knots or larger chips against the side of the tube. Those give an aweful squeaking. One of the smaller problems we encountered was the powerful ratchet on a lever right in the back of the 50 kW TP; it has no protection. Today I saw a number of things that concerned me, a lack of clearance around the appliances. If we are going to do demonstrations we have to pay attention to the overall safety of the installations.

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Ian: Thank you very much, Charles. Well, we will move on now. John Kipping is next on the program.

John Kipping

I have been involved with woodchips in New Brunswick, in the Fredericton area, since about 1980. I got started by being hired by Marc and Tony to run their demonstration program. I am a mechanical engineer by background.

Last year, Energy Mines and Resources issued a request for proposals on small-commercial storage and handling systems for P.E.I. The design criteria were: the system should be capable of handling both sawdust and wood chips; it must be capable of automated, unattended use; the control system must be integrated with the wood combustion system; the design of the system must include the means to convey wood fuel from the storage bin to the wood

combustion unit at a minimum rate of 50 kg per hour; the system must be capable of storing a minimum of 5 tonnes, or 20 cu. metres of wood fuel; it must be suitable for construction in larger configurations; it should be designed to accept chips or sawdust from available delivery vehicles; the system must be constructed principally from locally available materials and equipment; the system should be designed for minimum maintenance; it must be relatively low-cost and reliable; it must be for either indoor or outdoor storage; potential freezing problems must be addressed for outdoor storage; and outside storage systems can be either fixed or mobile.

We came up with a design for a mobile container. Because I come from a sailing background, I was aware of a particular trailer that to me made a lot of sense and could be used for handling containers for woodchip storage and delivery. It could be used for hauling, or transporting just about anything. We all saw Bulk Carriers roll-on and roll-off container handling truck today, but I think that one is $80,000 plus. Somebody who is getting into wood chip supply does not have enough volume now to justify spending that much money on a truck. We would like a piece of equipment that would enable them to handle containers as cheaply as possible. This trailer would do that. It has an open end at the back, so the trailer is actually a U-shape that can be backed around the container. There are four hydraulic cylinders which are run by a small gasoline engine with a hydraulic pump on it. These cylinders lift the container off the ground. It can be operated by one person. Transverse beams can slip either under the cradle or through slots in a container such as we saw today and lift it, so that it just clears the ground by a foot or 18 inches when it is actually being transported. So we decided to design a self-unloading container specifically matched to this particular trailer. The bin has a structural steel framework. It has sloping sides in the lower portion of the bin.

The opening is about 2-1/2 ft. across and it has three screw augers along the bottom of it so can actually self-unload. It has plywood walls lined inside with plastic coating, or fibreglass coating, so that chips will not stick to it, and we feel that this container would not bridge.

The gear motor and screw drive are in a compartment at the end. The electronics are in the bin as well. All that would be necessary is to plug this unit into a 115 volt power supply. Coming out of the bin the chips drop into a below-ground level conveyor that would pick them up and carry them into the building. One of the advantages of using that trailer is that you can have a taller container and thereby you maximize the volume of materials you can transport in one load and, of course, that is very important to reducing the delivered cost of wood chips. Question: What is the volume of this container?

It's 6.7 metres in length and it is 3.2 metres in height, and 1.7 metres wide. So it is not far off the dimensions of the containers that are rolled onto the trucks and lose about four feet of usable volume because of the height of the truck chassis itself. The empty weight is 4700 lb. and metric capacity is 26 cu. metre - 900 cu. ft.; the capacity is roughly six tonnes of dry chips.

The screw augers are heavy duty, standard-length screw conveyors. You can buy them in these fixed lengths right off the shelf. The reducer gear is the most expensive component in the whole system and takes the speed down to only several rpm, because it is designed to convey at exactly the rate that the burner would use it.

Question: How many h.p. are required?

It is a standard 110 volt 3/4 h.p. electric motor. The torque that comes out of that gear box is incredible. Roller chain is used for the drive so after it reaches a certain torque it will jump on the gear coupling rather than breaking something and a pressure sensor would shut the system down. So the idea is you either load this container on site and leave it there, or you actually pick it up with the trailer and take it to a site where they have prepared dry fuel chips, fill it up and take it back to the site, and in the meantime the surge bin on the burner could handle the loss of the supply for that period of time. We feel that the system is extremely flexible. The chip supplier has to buy only the trailer. There are two models of the trailer, a 6.5-ton unit which costs $12,500 and a 13-ton unit which costs $22,000. They are made in Hudson, Quebec.

We went to a local factory in Fredericton that is used to dealing with prototypes and asked for a conservative estimate. They quoted about $18,000 and we raised that to about $22,000 for the purposes of the prototype, and that includes all of the gear, sheeting, complete container. It is expensive. Without the self-unloading system you are probably down to about a third of that. They said that they would fabricate the structural container for about $5,000 or $6,000 without the unloading system.

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Ian: O.K. I thank you very much, John. And our last speaker for tonight is Dave Murray.

Dave Murray

I am with Crowfield Associates. We have been involved with wood chips and wood heating systems for about eight years. We were the other successful bidder on the study for wood-handling systems, along with John Kipping. We are looking at a container which is dropped off at the site. It is basically the same sort of container that you saw this afternoon in Jack Kelly's yard. We did not go into designing the truck and the mechanism for loading the container on the truck because there are quite a few different systems around. We were looking for the cheapest, reliable system that we could produce. What we came up with was a container which has the simplest system that I have seen working. We looked at two types of chip burner bins. One is the TP and the other is the Vallsta. Rather than overdesign the system we decided to take the other approach. How thin, how small, how flimsy, how few components could we put in and yet be big enough to do the job. What we have is a wheel agitator with teeth driven by a feed auger that runs along the side of the bin. The actual motor gear drive system is in the building. We also decided to have a small surge bin as part of the system, so you can completely empty the bin and keep the system going while the container is away being filled.

The bottom of the Vallsta bin is similar to the TP, a large wheel, but it is one piece. It has spokes that stir the chips. You have flame-cut teeth around the outside that are driven by an auger with constant pitch. The Vallsta system had a couple of problems: first was the wear from the metal-to-metal contact between the teeth and the auger; another one was the shearing of the centre

shaft of the wheel. So, we mounted the wheel up higher and supported it with ball bearing steadies all around. The wheel is mounted up off the base on a strong self-lubricating spherical bearing that never needs any maintenance. This type of bearing has a tremendously high thrust loading capacity. It is only $40 and it can take many tonnes. Below that we also put a triple-edged scraper seal to prevent water and mud from getting into the bearing. The other modification is the wheel drive teeth. We will try plate-hardening them to prevent wear. If that does not work we have designed another wheel with bearings as the teeth. They cost $6 each so they do add quite a bit to the cost. We also looked at containers. We worked with Robert Linkletter in Bedeque, an Island company with a lot of experience in building potato boxes and they came up with their estimates of the cost of a typical container. We designed the container, but we did not design the main rails underneath, and the hook mechanism which would pull the container onto the back of the truck, because that would vary according to truck system. We have suggested that initially we have two of these bins produced and operate both of them continuously, feeding each other at Bob Linkletter's place for a couple of months to see what the wear will be on the system. In the initial phase we have allowed $7,000 for a 20 cubic metre container, with unloading mechanism, to make sure that it will do the job. Remember, the motor is in the building itself so that is not included in the $7,000.

The gear motor should be about 1 or 1.5 h.p. with a shear pin or gear coupling to avoid damage if the system jams.

Question: The containers are rectangular or square?

It is 11 ft. by 9 ft., with one wheel, but you could extend the bin and drive a second wheel. Another thing I should point out is that you could put this system in a basement. The whole system could be installed on a concrete floor.

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Ian: I think we can call it quits for now, and I thank you very much.

Tuesday, May 26, 1987

Ian: Well first of all I would like to introduce Nazmir Bundalli from the B.C. Research Council.

Nazmir Bundalli

The B.C. Research Council is a provincial research organization located on the campus of U.B.C. We have been involved in a number of projects related to biomass handling.

Much of our work deals with various pulpmill fuels, which are harder materials to handle than woodchips. The biggest problem with pulp fuel, or biomass, or woodchips, is storage. When we started this project back in 1980 the first problem was lack of any proper design criteria. Essentially the approach to pulp fuel handling has been the use of brute force, lots of horsepower. These systems cost a lot of money to install and operate and maintain and they still suffer from a lot of problems. The first part of our research project was at a fairly fundamental level really. We built ourselves some test equipment to measure fuel flow characteristics.

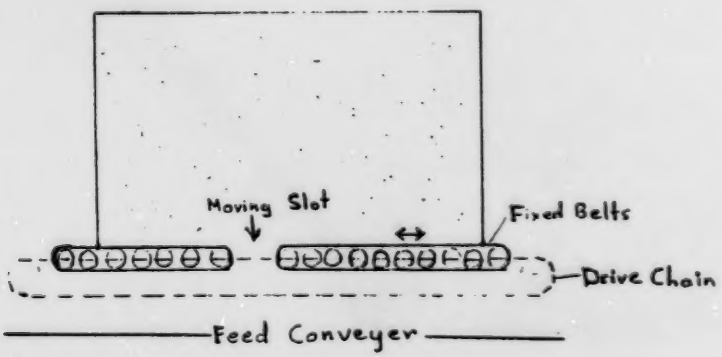
If your storage system design relies on material flowing over itself, the material has enormous resistance to shearing; it would rather bridge. On the other hand, we found that the material is relatively weak along the walls and that the forces that you have to overcome to get a flow are relatively small. It makes sense to attack the problem at its weakest point.

What our laboratory tests told us is that flow was feasible through a converging hopper. There are a lot of advantages in going through a hopper because you can have smaller, lower cost discharge feed systems. We found that the friction characteristics are critical. You want material to preferentially slide on the bin walls as opposed to funneling over itself, so you want a hopper that is sufficiently steep and smooth. When you get into proper, practical hopper design, you are looking into using a liner. High density polyethelene and glass-coated steel have excellent low-friction characteristics.

We went on to build a fairly large (300 cu. ft.) bin based on laboratory results. We could adjust the walls in and out so we could vary the width of the opening. We could also adjust the slope of the hopper so we could test the system at various hopper angles, as well as various liners. We tested both the high density polyethelene and the glass-coated steel lining. We confirmed that flow was possible through a converging channel and that hopper design was very critical. We went on to test different discharge feeders and we started with a multiple screw feeder. We had three screws in parallel. The first thing that happened when we turned the system on was that we broke all the bearings and bent all the shafts. It was not that the system was not strong enough; we found out later that the problem was that all the power was going into compacting material. The other thing that happens is that you have a mass of material at the front that just does not move. What we had to do basically was avoid the stress build-up in the lower front area.

We suspended the screw feeder on four come-alongs and dropped it at the front to open up a gap right above the screw feeder.This resulted in movement of material in the front part of the bin, and all the stress build-up that was occurring in this area disappeared.

NOTE: The tape recorder failed at this point. Nazmir went on to describe a non-consolidating feeder (NCF) which they have developed. It consists of fixed belts on rollers which move laterally (at 90° to the roller axis). The slot moves back and forth below the storage hopper. Drive-chains connected to the rollers move the rollers and the slot back and forth under the fuel. Fuel falls to a feed conveyer below as long as the slot is moving. There is no friction caused by dragging the fuel against any surface and no compaction of it.



The power requirement is very low. Patent application has been made for this innovative unloading system. There was much discussion throughout the workshop about the possibility of down-sizing this new technology for various installations.

NOTE: a small NCF will be installed at the fish hatchery, to drop chips into the top of the appliance feed hopper.

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Erik Gunnarrson

EGAB is a small company, situated in Edsbyn about 200 miles north of Stockholm.

We have 2 employees only, but are working closely together with another company in Edsbyn, called DRIVEX, employing about 20 people. They are manufacturing all the metal details for the fully automatic chip feeder and they are also producing mobile chippers. EGAB is handling the sales of the chip feeder, whereas DRIVEX is taking care of the sales of the chipper.

Apart from the sales of chip feeders, we are also offering complete construction of chip heating installations. In such cases, we are making the investment and selling energy to the customer. We are then of course responsible for the operation, fuel and service. At present we have 5 such installations working in our area.

A 24-hour watch is necessary and is taken care of by two men having that responsibility every second week. The man on duty carries a beeper alarm which can indicate that the system that is having a problem and whether it has a high-fire or a low-fire problem.

NOTE: Erik then went on to show slides of his various burner installations. He uses a 10-cubic-metre farm wagon and tractor for delivering fuel to small systems in the Edsbyn area. He expressed a strong preference for below-ground storage bins so that common trucks could deliver to them. Fuel quality, particularly with chips, is critical. Screening is too costly.

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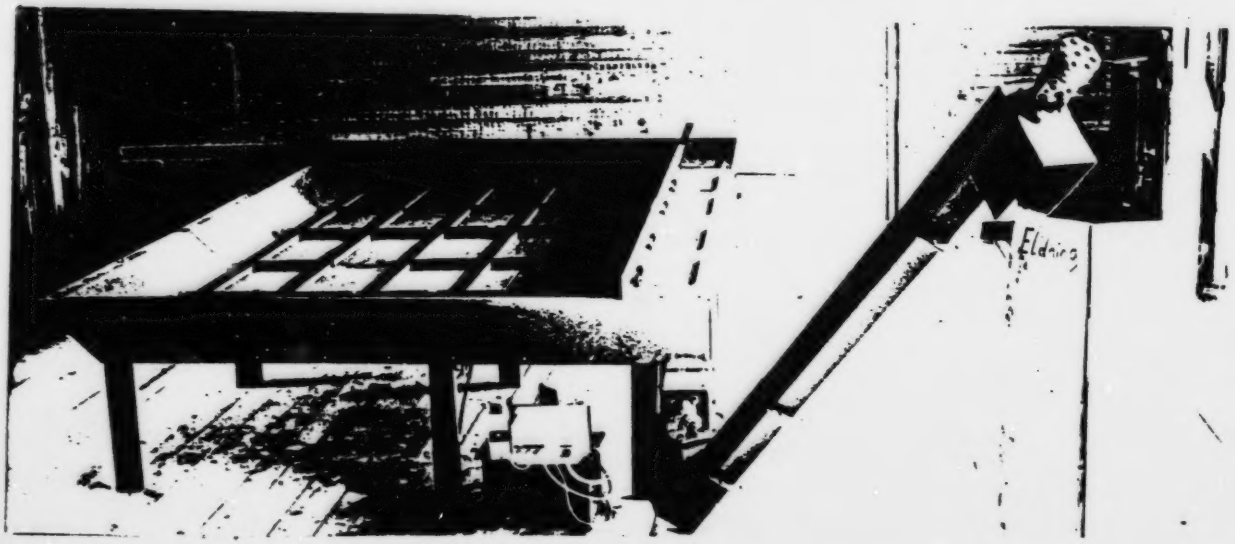

Bjorn Jansson

Bjorn Jansson spoke briefly about his company, Swebo Flis and Energy and the chip burners they produce. At one time he sold Swemo burners, but customers experienced difficulties with the control system. About 5 years ago he started his own company. They developed an electronic control system that greatly improved operating characteristics. They can now handle fuels from 9% moisture content (wet basis) to 50%, but he prefers 35-40% fuel. He personally retrofitted the new controls to all the Swemos that he had sold and many others as well.

Swebo Flis is now Sweden's largest manufacturer of small-commercial chip burners. Over 4000 units have been sold. They have 42 dealers in Sweden and also agents in 8 other countries.

Swebo Flis burners have a rugged feed auger which runs in a square feed tube. Jamming is generally not a problem. The sizes of burners include: 130 KW, 160 KW, 200 KW, 250 KW and 500 KW (a twin 250 kw system). The standard fuel container is 800 litres and a 4-cubic-metre bin is also available. The feed tube length is variable as is the angle that it enters the fuel cell. The de-ashing door can be on either side of the fuel cell.

Burners should be oversized somewhat for best results. De-ashing frequency ranges from 3-4 times/week for spruce chips to once/week for hardwood chips. A twin burner system works well where the load varies significantly, but it costs up to 25% more. It also provides greater security. Bjorn prefers the Finnish Etna boilers which employ vertical tubes and have fewer ash accumulation problems.

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Ian: I would like to thank you very much, Bjorn. Bruce, perhaps you would like to introduce Goran Stadigh.

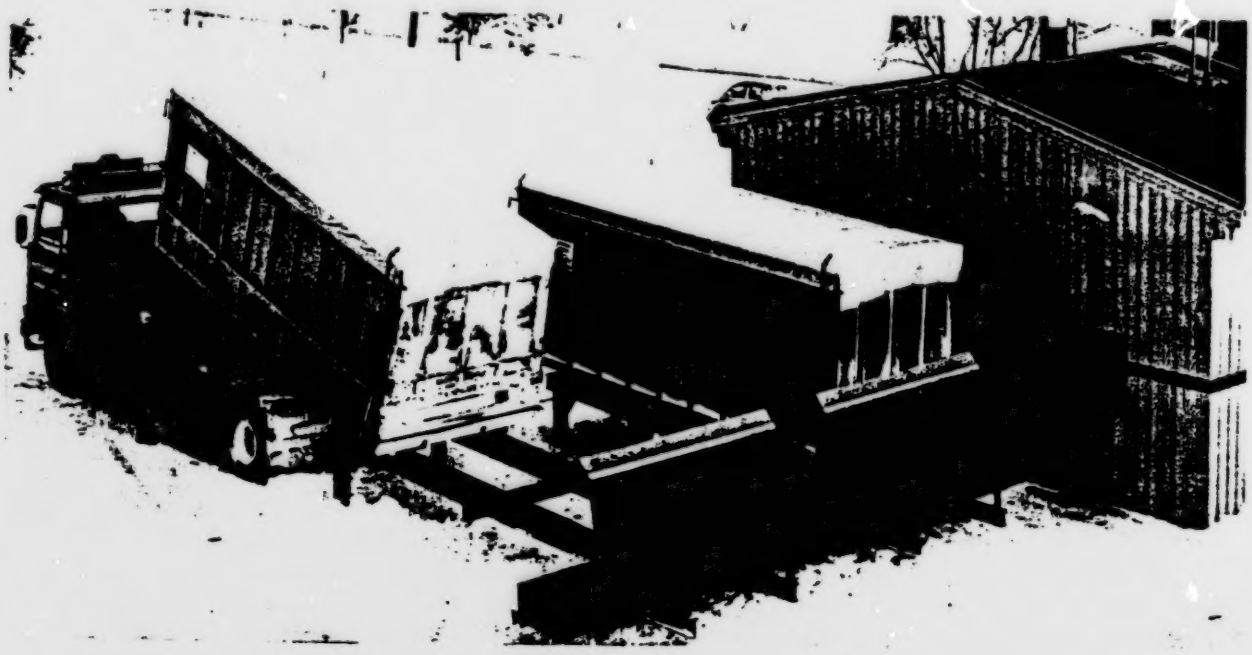
Bruce: In October of 1986 I went to an exhibition in Gothenburg, and one of the displays that I saw was that of Goran Stadigh who builds container handling systems. We have had many discussions about the possibility of using container handling systems in P.E.I. as a means of reducing chip system costs. Later on that trip I went to see a container system that was actually burning peat in a town northwest of Stockholm. There have been many further discussions about the possible use of containers here and I am hopeful that we might ultimately test and demonstrate these systems in P.E.I., and determine whether they do in fact really work here. They offer possibilities of cost reduction as compared to below-ground bunker storage.

Goran Stadigh

Well, first of all I would like to say thank you to Energy, Mines & Resources for inviting me here. It is the first time I am in Canada. I am a mechanical engineer, and I graduated in 1964. I worked in mechanical construction for other companies for a period and then in 1972 I started my own company, Goran Stadigh A B. During the period 1972 to 1975 we worked as constructors for different companies in the area of mechanical engineering.

1975 we started producing hydraulic devices combined with electric devices for hydraulic manure handing equipment that automatically transports the manure from

the cow shed to a concrete slab outside. All the components that we did not find in the open market we simply constructed ourselves.



We do design work and fabrication of hydraulic and electrical components. Steel fabrication is done by another plant. In 1979 we were asked by the local authorities in Are to create a container system for handling of woodchips for burning in solid fuel boilers in central heating plants.

After various tests we felt ready to demonstrate our self-feeding container to the authorities in April 1980. The outcome was an order of 9 containers including hydraulic equipment for 3 district heating plants in the area. The heating plants were started in November 1980. The first containers were built completely in steel and were planned to be placed indoors - in a heated room. The fuel was chips and bark with a moisture content up to 55%.

The containers are either 20 or 30 cubic metres. They are always handled with trucks equipped with the hook lift which are very common in Sweden. Very soon they will be common here in Canada also. In Sweden we install enough containers to carry a plant for 72 hours or 3 days. If it is accepted that storage needs to last only 24 hours, the number of containers could be reduced.

There is an angle bar that keeps the scrapes on the floor. One hydraulic cylinder under the container drives the scrapes. The truck driver has only to connect two hoses with quick couplers at the plant to activate the container.

In order to have control over thw whole system, we started to construct all the equipment needed, around the container concept, including the conveyors.

Screw conveyors with a central shaft did not offer the flexibility we wished. Scraper conveyors with double chains did work but were complicated in construction and thus expensive.

In plant 23 we tested our first screw conveyor without a shaft - the spiral conveyor. This has many advantages: Firstly, it is cheaper and it can also be made whatever length you wish. The conveyor will "swallow" the fuel without any hindrance from a central shaft. The spiral will lift if the fuel gets between the thread and the trough - when a conventional screw conveyor easily will get stuck. The length of the conveyor can easily be adjusted when installing it. Today 26 spiral conveyors are installed in 14 plants.

Experience from the early systems taught us that if the fuel has a fine fraction and its moisture content is more than 40%, the walls have to slope inward toward the top to avoid bridging and the wall materials should be plastic-coated plywood to avoid problems with fuel freezing to the walls. Fuel must be taken from the container continually once it is at the plant even if only at a slow rate to avoid freezing. It could be there for a week as long as you are moving a little bit of fuel all the time.

Instead of first building a steel container that afterwards has to be lined with plywood, we started from plant 23 to build the containers with steel frames that were covered with plywood. That construction became in that way both cheaper and better. The price in Sweden is $16 - 17,000 for the 30-cubic-metre containers. That does not include the feed system. Today we have 137 containers working at 46 plants all over Sweden.

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NOTE: Goran Stadigh showed slides of a number of installations and described various features of the container system including: the scrapes, feed conveyors, hydraulic drives and safety and control systems.

The remainder of the workshop consisted of intensive discussions concerning optimum equipment selection for each of the sites visited on the first day. Each participant had a data sheet for each site, including equipment suggestions.

<u>Seaman's Beverages Ltd.</u>

Bruce McCallum: Does anybody have any comments on what was suggested for Seaman's? - The size of the burner came from a feasiblity study Coles Associates did on the site. I cannot really vouch for the accuracy of that size.

Ian Flann - Question: Assuming the size is right, what appliance should we choose?

Bruce McCallum : There are now three 50 h.p. oil-fired boilers and my understanding is that they generally use two, and have a third as a standby unit.

Robert: Christmas time is their peak demand and they run the three of them on an average of 72% duty cycle which is more than what is recommended.

Bruce: I suppose the alternative to the Goran Stadigh container system would be a below-ground bunker fuel storage of the type that we saw yesterday at the high school in Montague, and various others around Charlottetown and elsewhere on P.E.I.

Ian Flann: One question or point that wasn't brought up this morning; what do you think is the minimum size in general that can justify the cost of putting in your system?

Goran: Well it is a difficult question because it depends on how much the boiler costs.

Ian Flann: At current oil prices, how many kilowatts.

Goron: It can be used down to one hundred kilowatts.
Bruce: One other thing that wasn't stated in the information package was the type of boiler and combustion unit that would be used at Seaman's. I was assuming something like a Silva or a KMW fuel cell, and a Bell boiler or a Matheson.

Nazmir: I feel that this site would be an ideal application for our new feeder system. I think that you could design a system to suit any configuration. You have shown in the drawings a 25' bunker; that could be done by putting it below ground or above ground.

John Kipping: If we could back up a bit here, has anybody analyzed the economics of each of these installations to see, given a certain price for fuel delivered, what actual capital cost can be afforded over, say, a 15-year cycle. How much can you spend on a system?

Ian Flann: John, we know that the price of oil is going up, so today's economics frankly are irrelevant as far as I'm concerned. What we want to do is learn what are the best combustion systems, what are the best handling systems, predicated on the assumption that five or ten years from now several systems are going to be economic.

Bruce McCallum: The other comment that I would like to make is that in suggesting these various options I generally attempted to propose the lowest cost options that I felt would work effectively. Usually I have started with the minimum cost system that I thought would work and later on suggest slightly more expensive solutions. Certainly the more money that you throw at a problem, the better it will probably work, but you may very well get beyond the point of an economic return. I have to agree with Ian, one of the main objectives of the project that we are talking about here is to test the technology, and the economics are really something that will be more important down the road than at this point in time.

Jim Richard: Just a point on the economics, in New Brunswick on long-term chip delivery contracts signed, the agreement is that, as the price of oil goes up, the price of chips go up accordingly.

Bruce McCallum: Well that may be, but there may be other contracts negotiated that do not provide a direct correlation between the two. I would hope that they don't. What does Jack Kelly have to say about that?

Jack Kelly: That's a good question. Obviously the return has got to be there. If oil prices go up in 5 years time, everything will be up including our operating costs. I am sure that it will have a bearing on our chip prices.

Ian Flann: I think that it is fair to say that everything that we are doing here today, and in this area in Canada right now, is predicated on the assumption that the price of biomass is not going to go up as rapidly as the price of oil. The forest is renewable, the oil well isn't.

Bruce McCallum: Well there is certainly no question that as the price of oil goes up, it will open the door for rises in the price of wood. My hope would be that those increases would reflect more the cost, rather than a direct correlation between the cost of oil and whatever you can get for wood, but it's really going to be determined by the market.

Ian Flann: So are we going to concentrate on the combustion systems first or on the fuel handling first?

Bruce McCallum: Well I don't know whether there are many people who have comments on the combustion system; it seems to me that the combustion systems are fairly well proven here in that size range from Canadian companies such as Silva, and such as KMW which is a subsidiary of a Swedish company.

Ian Flann: Does anyone see a better system? We saw a modern system at the Montague hospital yesterday. It is roughly the same size as Seaman's. Does anyone feel that there is a better combustion system or a more appropriate combustion system that should be considered for Seaman's?

Tony Short: I have a question in connection with the estimates that you are showing. How did you get these numbers? What all is involved? Would any part of the container system be built here?

Bruce McCallum: The numbers basically come from figures that people such as John teRaa of the P.E.I. Energy Corporation have given me as to system costs and prices that, for instance, Goran Standigh has provided on his system in Sweden, plus a calculation for transport and duties. I would hope that in the long term his systems will be, if they prove successful, manufactured here under license. What is your feeling about that Goran?

Goran Standigh: Well, in the beginning almost a complete system should be shipped in a container and assembled here. But the frames use only dimension steel, and eventually most of the system could be built here. The conveyors should be imported. For example things like the spiral perhaps could be made here in the long term but not initially.

Tony Short: Now when it comes to handling the containers, you showed a hook truck which I don't think that I have seen on this continent.

Bruce McCallum: You saw one yesterday. Bulk Carriers use one to deliver chips to 5 or 6 sites in the Charlottetown area. Do you have a comment on that Jack?

Jack Kelly: I must say that I was fortunate enough to visit Sweden last May and see many of these container systems in operation over there and it seems to me that it is a very very practical system. I think that containers apply excellently here especially to places like Seaman's Beverages and the Government garage and small hotels and even farm use. I don't see them being the answer for residential use but for farms and industry, I think they are excellent. Very simple certainly; they can be constructed locally and I'm sure it's a very practical system.

Charles: My question is a bit general. What are we looking for, is it to try to demonstrate a number of these technologies so that we can make experience-based decisions in the future? Is that right?

Bruce McCallum: Yes, but I think that we have to consider that there are two types of technology that we are discussing here. For instance, Goran Standigh's system and some of the others are technologies that have not been demonstrated here but are working very effectively, for example, in Sweden. On the other hand when we are talking about Nazmir's technology which is very interesting, and perhaps Dave Murray's or John Kipping's designs which are designs only and the first systems would be prototypes. I think we have to treat them a little bit differently than applying a proven technology. And there may be special measures taken to compensate for that in some way. It may even be that prototype systems should be bench tested before site testing.

Dave Murray: Bruce what is the objective of this program then? Is it to provide an opportunity for new types of systems to be used and demonstrated, or is it just to demonstrate well proven technology, or a mixture of both?

Ian Flann: In this workshop we are discussing the sites visited yesterday and trying to determine what would appear to be the best selection of combustion and chip handling equipment for these sites. We are hoping that another project goes ahead and actually finances these installations to various degrees. Also, in today's newspaper, there was an ad under the ERDA banner asking for further expressions of interest from site owners in the small-commercial range in the Montague, Charlottetown and Wellington areas. We have this workshop to try to clarify ideas concerning selection of equipment and we are hoping to use that information in a future project on P.E.I., the obective of which is to develop expertise and technology, and to get accurate figures on the capital cost and on operation and maintenance costs so that in 3 to 5 years down the road we are in a much better position to make intelligent choices. Let's try to be prepared for the next oil crisis.

Bruce: To conclude with Seamans Beverages, it certainly is an ideal site for a container system.

Vince Court: I think that this site is the perfect size for a container system because it will allow for two and one half days of storage, so if in the winter the trucks couldn't get there for a day or two, there would be enough fuel to carry them through.

Bruce: One other point that I might make. My assumption in suggesting a one-container system was that there would be an intermediate surge bin that might hold 3 to 5 cubic meters so that one container could be removed and that there would still be 5 or 6 hours of chips in the system, to allow for pick up and return of that container. Goran questions whether it is worth while to do that or whether it is better to put your money into a second container. Once you have a number of these things in place, there will be extra containers and the containers will move back and forth, and simply having one container is not going to be a problem, but in the beginning there could be, with the first systems.

Ian Flann: We will have to examine the cost both ways, the extra container versus the extra cost and complexity of the surge area. But that's almost a detail that will come a little further down the road.

Bruce: My assumption is that if this was put in Sweden you would have two containers for this system.

Goran: In Sweden we would have 3 or 4 containers.

Jack Kelly: I would have to agree with him once the container system is set in place extra containers are just the cost of the container simply. You are not dealing with any extra system cost.

Ian Flann: Okay are there any further questions or comments concerning the Seamans Beverages installation?

Comment: I think that it is the ideal site for a central heating plant for the whole industrial park up there, and whether it is private enterprise or government that gets involved and builds a system where they sell heat, it seems to be the ideal location.

Bruce: Yes, somebody is going to have to address that and make a decision whether we are talking about a plant only for Seamans or whether we are looking at a system for the whole industrial park. I think that it's a great idea. You would then be talking about a 5 or 6-container system.

Ian Flann: That is a very good point. I think at the moment we are just trying to find out what is the best technology and what the costs are for the various better technologies. We wouldn't like to bite off something quite as large as the whole industrial park. But idea that you are getting at is very true, no question about that.

Bruce: There is another advantage that I see to these systems and that is it is very easy to simply add more boiler capacity and more containers with the same basic handling equipment.

Jack Kelly: The systems that I saw in Sweden heated towns that were bigger than the area of the Industrial park so a container system would be a good possibility for heating the whole park.

Vince: Should you tie your capital up in containers at the site, using them for transport and as bulk storage, or do you use them just for delivery and have a bunker storage?

Jack: I guess it comes down to the bottom line for those installations. It seems to me that if it is a location that is using a large volume it might well be that your bunker system is best. But I think that we have many places on P.E.I. that are only using a container every two or three days and I think that even in the winter, when it's one container a day, then it seems that it should be a container system.

Comment: At the university they use 5 or 6 containers a day. If you are burning six containers a day, obviously you would have to have 6 containers on site.

Goran: In Sweden you don't buy extra containers. You simply buy the containers that you have space for at the boiler plant and during a normal working day only one or two are working at the boiler plant, depending on how big it is, of course, but otherwise they are in the woods being refilled.

Bruce: Jack, how often do you deliver to sites now, 5 or 6 times a week?

Jack: Well, in the winter months when the demand is on we are going 7 days a week and that will continue to be the case. I mean the way business is, the more hours you get out of your equipment the better utilization you get.

Bruce: So you are happy to see it working 7 days a week, as many hours as you can justify operating?

Jack: Well I guess that's just the way business is done. If you are in the oil trucking business as well, in the winter time you have to operate 7 days a week. That's just a fact of life.

Ian: Lets move on to Neil MacDonald

NEIL MACDONALD

Bruce: My first option was a Swebo Flis 65 kw and you might note here that I had discussed this with Eldon King, as I did with all the sites in the Montague area which he identified. His opinion was that you could probably get away with the 65 kilowatt system there. I'd like to know what Bjorn has to say about that.

Bjorn: I think that it is better to take a bigger 130 kw than to drive a 65 kw very hard. But you must think about the existing boiler. If you use this boiler you will have very high stack gas temperatures. You can have 600-700 degrees in the chimney.

Bruce: So your preference is to put in a new boiler.

Bjorn: Yes, a new boiler. You can throw this boiler out in the street.

Ian Flann: Yes. Lets forget that boiler.

Bruce: I'll agree to that, but I'd like to make just one final comment. If you need to minimize your installation costs, using the existing boiler will help to do that. These are not optimal boilers, but in some situations people will choose to use a less than optimal boiler for its remaining life-span and ultimately replace it with something better.

Vince: In a lot of cases I think those roundwood boilers could stay, and install another boiler beside them. A lot of farmers need to incinerate dead little pigs and syringes and so on and also a lot of them want to burn large roundwood sticks that they can't chip.

Bruce: There is another consideration regarding oversizing the burners, especially on these farms sites. They frequently expand. If you have an over-sized system, that allows some extra capacity that can be tapped at a later date. I'm sure that this applies to both Linden Lee farm and James Allen. Do you have any comment on that, Eldon? You though that you might get away with a 65?

Eldon: Well, Bjorn has been talking about oversizing. He explained that the Swebo has a good turn-down ratio. A lot of burners that have been oversized, haven't worked too well.

Ian Flann: There is another possibility that I would like to introduce. It could very well be a twin installation, a 65 Swebo and a 30 kw of some other type.

Bjorn: Oh yes, sometimes you can have two smaller units because you can run both when it is very cold and when it is warmer you can put out one burner. It is easier than one and you have a better system security if you have two. If something happens to one you still have the other one.

Bruce: Bjorn what is the cost of two 65's as compared to one 130?

Bjorn: It is more expensive; I think it can be 25 - 30% more.

Eldon: Neil suggested that he would like to burn sawdust. What is your opinion of the sawdust-burning IWABO (a gravity-fed appliance that has been in production for 15 yrs.)
Erik: Many Swebo in Sweden are burning sawdust, but IWABO is good when you have good sawdust.

Bruce: He is storing that sawdust over the summer months inside, and my assumption is that his moisture content is going down quite a bit; is there a lower limitation for the IWABO for instance? Which one will handle the driest sawdust?

Erik: Swebo, I think.

Bruce: Wanson Hemphill, what is your guess as to the moisture content that Neil MacDonald is getting with his sawdust?

Wanson: I don't know, I just gave it the finger test; it's about 35% - 40% I guess.

Bruce: Erik does that conform to your experience with the IWABO?

Erik: Oh yes.

Bruce: So from that point of view perhaps the Swebo is better because it can handle the drier fuel?

Bjorn: Yes, but if you have much air in the dry chips or shavings you must mix it up with sawdust in the summer (to prevent burn back). If you take a big 250 kW for example, with dry shavings material, you have so much air so that you must mix it with sawdust.

Bruce: We have only talked about option one which was Swebo. There were two others suggested. I made the assumption that you could burn sawdust in both the TP and the Vallsta. I may have been wrong in that assumption. I would like to ask Charles his opinion on that.

Charles: If the sawdust is as dry as we saw it yesterday I don't think it would be a major problem. The big problem with bridging was with very wet sawdust and that is not what we have seen.
Bruce: Vince you have had some experience with the 30 kw TP. What is your opinion on that?

Vince: If the sawdust is dry enough then there is not a problem. If we extend the agitator I don't see any problems. With a whip or something there would not be any problem at all if the sawdust was dry enough.

Ian Flann: Tony would you like to comment on the Vallsta and sawdust?

Tony: My observation and experience with the Vallsta was that the sawdust seems to blow off the grate before it burns, as you saw on that slide a night or so ago. Marc, can you comment on that.

Marc: He has a problem running that thing on hardwood sawdust.

NOTE: A lengthly discussion followed on the practicalities of burning sawdust in stokers. In a subsequent discussion with Lennart Nylander who developed the Vallsta burner heads in 1978, he indicated that you can burn sawdust in the conventional burner heads if you mix it with chips. However, he sells burner heads that are specifically designed to burn straight sawdust. He also confirmed that the larger the burner, the wetter the fuel it can burn, up to about 50% moisture content.

Ian Flann: Let's talk a little bit about material handling, sawdust and chips, in a place like MacDonald's farm.

Bruce: My assumption was that this is a very small system, and you cannot afford to spend a whole lot of money on fuel feed equipment such as EGAB or a Vallsta system. So basically he should be looking at maybe a little inclined escalator into which you dump shovel scoops or something a little bigger that would feed into the open fuel bin, and then when it is full you simply shut the fuel bin again and continue. There are any number of ways you can automate it but your costs are going to be higher than what the system could justify, in my opinion.

Tony: Swebo doesn't require a closed feed bin does it? Is the top on the chip bin gasketed and sealed or can you operate with it open?

Bjorn: It can be open. In Sweden we must have it closed for safety, but 99% leave it open.

Bruce: That personally concerns me a little bit and I wonder, with regard to the TP which seems to be sensitive to burn-back if the top is open, if there shouldn't be some sort of alarm mechanism indicating that the top has been left open. If it was in my house, that is what I would want.

Vince: I think with our power failures here they should have sealed tops of some kind. The power supply is too unreliable.

Gun: We have a dowser so that it won't burn back.

Bjorn: For Swebo we have an electronic box that can be installed in the house. You can see everything that the Swebo is doing. If something is wrong, you have the alarm inside. And you can also have a radio alarm, like Erik's.

Ian Flann: Why can't you have a large bin, have Nazmir's NCF on the bottom and an elevator conveyor that would feed the hopper on the appliance.

Tony: What he would be doing would be shovelling stuff on to the escalator and the escalator is replacing just the carrying of the garbage can up to the top of the hopper and dumping it in. I'm wondering whether it is really justified, frankly.

Bruce: I don't know. I have seen other people do it and they seemed to be convinced that it was of benefit. I saw a chicken operation in Finland that had similar requirements and they were operating it with a large grain auger in the way that I'm describing. Now the grain auger would be much more expensive than what I'm describing, but then the fuel was 10 metres or 15 metres from where the burner actually was located. I think that for these small systems some manual labor is the only option. I don't think that it is necessary to eliminate manual labour altogether.

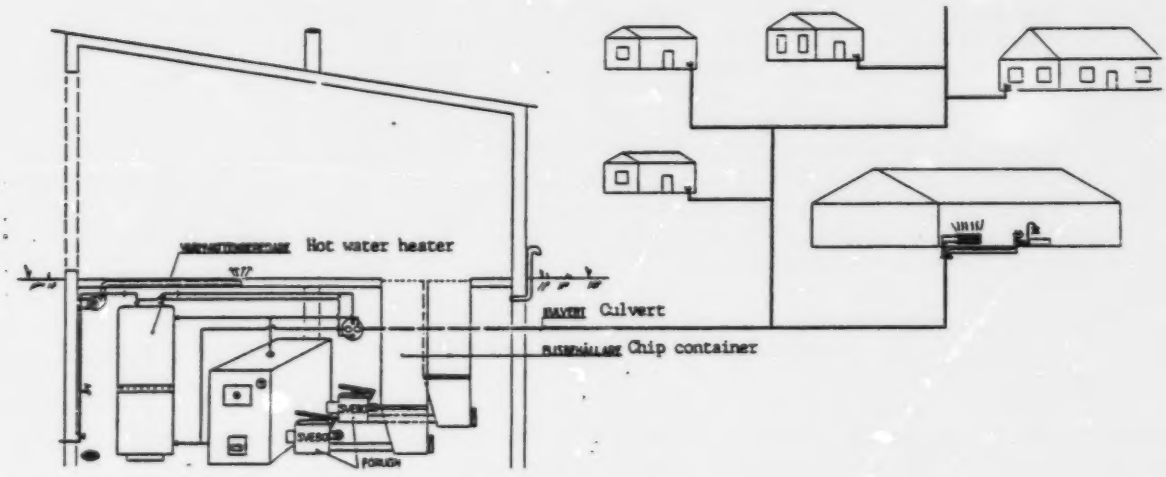
Charles: What is the capacity of the bins on the Swebos.

Bruce: The standard bin is 800 litres and the largest is 4 cubic metres. What's the height of the 4-cubic-metre bin, Bjorn?

Bjorn: 2 metres.

Bruce: So that would be possible on this site? There is a point I would like to make here with regard to manual involvement. Bjorn had a drawing that he showed me of a system built on a grade where the fuel bin was above the actual combustion system. So you are using gravity. You simply open the door and push the fuel down. To me this, for a small commercial system, is ideal.

Bjorn: And they have a very good system for drying the chips on the floor.



Charles: We are dealing with a low density fuel here and I think I'd look for a high volume bin on this one. Four cubic metres starts to sound quite interesting.

Vince: Neil stores his sawdust in another building. So he could have an outside bin that he could fill with a front-end loader. You could have it next to the outside wall with some sort of a hopper with a lid on it.

Bruce: If you had the 4-cubic-metre bin that would be practical.

P.E.I Dept. of Transportation Garage

Bruce: As I said before, I was looking for possible container system sites in the Charlottetown area for delivery reasons and where aesthetics were not critical. The garage came up in discussions with John teRaa. After some hunting I was able to get the fuel figures for 1986 which really astounded me, 244,000 litres. It is obviously quite a large system and definitely beyond the small-commercial scale. On the other hand it is probably an ideal application for a container handling system. The only problem with this site really is that the building may be moved some time soon.

Joe Caswell: Well it is something that has come up a couple times in the last year or so, but there is nothing definite at this point.

Bruce: From my point of view it doesn't bother me too much that the building might actually be torn down since a container system is very mobile, especially if you are talking about a containerized boiler room as well. The system can simply be picked up and moved somewhere else.

Ian Flann: What about the combustion system itself?

Bruce: As far as the combustion system is concerned, John teRaa supplied the information regarding the capacity of the system. He suggested 800 kw. and I would assume that we would be looking at a conventional Silva, KMW or TRENT type combustion system in that size range. There could be other solutions perhaps, but that is what I was thinking of. One make that hasn't really been discussed at any great length but that interests me a little bit, I might say, is the BioFlamm from Germany. They are somewhat similar to Swebo but they have a wider range of sizes. I think that they go up to 1.5 mega watts and down to 30 kw. They do offer automatic de-ashing which is not available in most small commercial chip burners. If we were wanting to test at that size range something new and different, BioFlamm is one that we could consider. But I don't feel that the Silva or other systems that we are using now are inadequate, particularly in those size ranges.

Art: Bruce, my personal feeling on this is that this is not a site that we should be looking at, if there is a likelihood that they are going to tear down this building.

Ian Flann: Well, is there any more comment on the Transportation Garage? If not we will move to the Kings County Construction Garage.

Kings County Construction

Bruce: This is a very small system. My feeling was that if you are going to retrofit this for chips you should, again, try to do it at fairly low cost, otherwise it simply would not make any economic sense. So I was suggesting a 50 kw TP stoker, again possibly with some assistance to load the fuel, a small escalator or something like that.

Alternatively you could be looking at a Vallsta which would be slightly more expensive than a TP, or possibly an IWABO. I had in mind going in the front and keeping the whole side area for fuel storage.

Tony: I am wondering whether or not this site is even an appropriate location in which to install a demonstration burner, given the general condition of the place.

Bruce: Well, you will notice on my note that it says - Site Con: Garage is a bit messy - perhaps I should have said very messy.

Eldon: Well if you are going to have any problems with it there are enough people there to take care of it. Somebody is there 18 hours a day all winter.

Art: I think that Tony would agree though, that this goes a little bit beyond that. There are safety hazards there, clearances have not been established on chimneys and ducting and various other things.

Dave Murray: If I could just make a comment. All three of these units are obviously about the same price; I think that we should get experience with all of them. I also think that for small buildings we do not need to consider automation because they can handle the small amount of chips involved by hand.

Ian Flann: Do any of our friends from Sweden have any comments?

Bjorn: Vallsta is not in the market now. They have big problems.

Ian Flann: We know that they are having a few financial troubles if thats what you mean.

Bjorn: You don't need to take Vallsta equipment. You can take the electric automatic ignition and put it on a Swebo stoker if you want. I have sold some, not so many, I think twenty. You get the burner head and controls from Vallsta and everything else from Swebo.

Art: I have a comment here as well. I have problems with these first two systems, both the TP and the Vallsta, from the point of view that they violate one of the basic principles of good combustion and that is they start removing some of the heat before the burn is complete.

Bruce: I'd like to hear what Tony has to say. You tested a small Vallsta. What kind of efficiencies did you think you were getting in terms of combustion.

Tony: Combustion was not as clean as we had been able to achieve with a couple of other burners, probably because of the manner in which the Vallsta was inserted into the CTC boiler. There simply was not a port big enough on the CTC to admit the entire grate, the grate was partially shielded. I think the sort of comment that Art is making a completely valid one.

Ian Flann: Bruce, isn't Art really saying that for this installation it would be better to use a pre-heater such as the Swebo or the IWABO?

Bruce: Maybe an IWABO; with an IWABO you can still put it on wheels and move it around. Perhaps this would be the place to try it.

Ian Flann: We seem to be agreeing that it should be a pre-heater if the site is used at all.

Bruce: We are also kind of tip-toeing into this debate as to whether pre-heater systems are better than stokers. That's a delicate one.

Art: If you wanted to use something like the TP or the Vallsta and if you are getting into much drier fuel, then it is not as important to have that pre-heater. Because your burn can be hotter without getting into so much shrouding.

Bruce: Yes, although I think we assumed an average of 35%? But certainly if you get into wetter fuels it would be a problem.

Vince: The IWABO, is that a stoker-feed unit or a gravity-feed unit?

Ian Flann: There are two IWABO's, a gravity-fed sawdust burner which has been in production for quite a long time, and there is a relatively new IWABO stoker--fed, chip-fired burner. The old IWABO is considered unsafe.

Bruce: The IWABO, the new one, is like a hybrid of a Swebo and a Vallsta. It has Vallsta-type electronics; it is a pre-heater and it has a light-duty feeding bin. I think the feed tube is bigger in the Swebo. The Swebo is more of a commercial machine and I would say that the IWABO is more of a residential machine.

<u>MacLaren Building</u> (a senior citizens' residence)

Charles: I think you need a good revamping of the whole installation.

Dave Murray: I would comment first of all that you should get rid of that boiler; it has horizontal tubes and it's terrible.

Art: I would like to comment that this would be an ideal installation to put a complete boiler room outside and forget that boiler room. I think that you would be much safer to go outside with a new package.

Bruce: These are fair comments, although the site was included as a typical problem. How do you retrofit tight spots like that?

Ian Flann: Let's assume that all the present equipment is thrown out. Okay what about the choice of equipment?

Dave Murray: There is obviously no room for the fuel bin to be inside. That is quite clearly an external fuel bin to say the least. I would suggest a container.

Bruce: I suggested three options, one was a Swebo Flis, number two was a Vallsta, and the third was back to Swebo Flis with a different fuel bin.

Tony: Sounds as though Vallsta's out.

Bruce: Well the question is, which are the better types of systems. The pre-heater systems or the stoker systems? It depends to a certain extent, I think, on the fuel. You need drier fuel for stokers. I did see Vallstas of 150 kw in operation that seemed to be working quite satisfactorily. What do you think, Erik? If this was in Edsbyn what would you do?

Erik: I would use the boiler room. It is very bad now but it is more expensive to go outside. If you take everything out and fix it up, it is possible to retrofit the boiler room.

Bruce: I had in mind an above grade outdoor fuel bin with some sort of top opening that fuel would be elevated into.

Erik: You must think about how you can get the chips to the bin.

Bruce: Yes, of course. It comes back to delivery, but the problem is when you go down, your costs go up.

Tony: Except that almost any truck can be used. It will require specialized vehicles and specialized conveyors if you are conveying upwards, plus the mess.

Bruce: Eldon, you have talked a lot about a specialized chip delivery vehicle servicing a number of units in that area.

Eldon: Yes, we are working on something like that. I hope it will be operating in a 6 to 8-week period. We are going to use a potato bulk box with raised sides and we are going to use a morbark chip blower.

Tony: How much air is the blower moving? You might have a dust problem.

Eldon: I was talking to people from Morbark and they didn't see it as much of a problem. The air flow can be controlled to what you want. They said it is no worse than a chipper.

Ian: Let's talk about how we get the chips into the boiler room.

Bruce: My first choice was a Biomatic fuel bin. It looks like an interesting machine to me. It moves chips with a type of a hydraulic ram.

Bjorn: I have a couple installed with Swebos in Sweden, I think two or three and they have chips and mixed chips. No, it is not a problem.

Ian Flann: The other day Tony was mentioning what he has in his basement right now, which is a 5" flexible agricultural pipe with a hollow auger running inside it. Could something like that be used for feeding from outdoors into the top of the hopper in the Swebo?

Tony: Yes, theoretically. The thing that I haven't tested and have no idea of, is just how long a distance you could convey chips. Now we are going about 15 feet. I am sure we could add 5 or 10 feet but I don't know if we can add 20 or 30 feet. I don't know what the limits are.

Bill Lowe: You have had noise problems with that system haven't you?

Tony: Yes. What I have done to get around the noise problem is to have a time clock so that the auger is forced to run at a convenient time of day. I don't want the thing cycling on at 2 a.m.

Bill Lowe: But perhaps it is harder to determine a 'convenient' time of day or night with this particular application.

Bruce: Goran, your screw is a spiral. Can you scale that down for a site like this?

Goran: No problem at all. You can use the container bin as storage or a stationary bin placed outside and, depending on the fuel, you can use the spiral conveyor.

Ian Flann: Nazmir, is this a place, for example, where we could have your rig as a permanent installation immediately outside that boiler room? Someone would wheel in a container with a drop floor and in effect set it down on top of your rig and away it goes.

Nazmir: I think so Ian, having the discharge feeder permanently located on the ground so that you can basically bring in a container and put in right on top of the feeder and empty the container out. This way you save the trouble of hauling the discharge equipment and avoid a lot of wear and tear on the feeder mechanisms. I think my system could be well adapted to this.

Bill: I am wondering if this is not an excellent site for a completely pre-fabricated system. You bring it in, literally dump it on the back door, connect the pipes and hoses into their heat system and at your leisure you can dismantle the existing boiler house.

Tony: Well it looks as though we are going to put in a whole package unit, and throw the rest out.

Vince: I would throw it out. I have not seen this site, but if there are a lot of people involved I would sooner have the package deal outside the building.

THE MONTAGUE TOWN HALL (needs new system by October, 1987)

Bruce: Montague Town Hall is a new system. It should logically be installed adjacent to, or as part of, the new maintenance building. Perhaps we should debate whether it should be an outdoor package system or a permanent indoor installation. But since there is going to be a new building there, it would be easy to design a permanent installation.

Tony: The container package is somewhat more expensive, I take it. Or is it necessarily more expensive than a system fabricated on site. You are paying for labour at the factory rather than the labour on a building site, is that the difference?

Eldon: I think the container system is cheaper than on-site jobs.

Ian: Erik, what is your opinion? Would you like the system pre-fabricated in a plant and delivered on site? Or, do you prefer using a fixed building and putting the components in it?

Erik: In Edsbyn we use trucks and deliver only to underground fuel bunkers. I also use a tractor and farm wagon. You have no problems when you have underground storage. You can use anything to put the chips in the bin.

Comment: This is a case where you have a new building going in. You are going to have excavation equipment on site. The additional cost for a below ground bin will be minimal if it is part of a building construction.

Ian: Well, that is right, and as far as this site is concerned, it is going to be fairly costly. A lot will depend on the dollars that are ultimately made available. It could be designed for chips, but use oil during the first winter.

Comment: Yes, but one thing we have to remember is that things become infinitely more attractive if there are elements of cost-sharing.

Ian: My assumption is that cost-sharing is a very real possibility with virtually all of these sites. Now, exactly how and what portion and so on is to be determined.

Art: It is a good spot for a demonstration.

Bruce: If we opt for a package system, I was suggesting Ranheat. Ranheat is a Danish company that specializes in package systems. I was particularly attracted to Ranheat because I know that they have specialized in complete container package units.

Art: I am with you. I have seen some of their equipment and it is good.

Bruce: I assume that we are now talking about something more than 130 kw. I think that we are now looking at 200-250 kw.

Comment: So you probably would need a bigger container if you set it in-ground so that it would take a full truck load, the same as the school would use.

Question: John, what size is your chip truck?

John: 39 cubic meters is the small one.

Bruce: Erik, how much much would that system cost with an EGAB fuel bin?

Erik: All told, about $50,000 including the burner and boiler.

Iceland Arena

Bruce: Well, this is clearly a retrofit situation in my opinion. You have a very good building and lots of space and a boiler which is perhaps not ideal, but which can be modified. The combustion system possibilities are several. I would use Swebo and Vallsta, and for fuel bins either EGAB, Vallsta, or something that Eldon King would build, which would perhaps be lower cost, and that would also have a hydraulic scrape and hydraulically-driven augers.

Note: There was some discussion about using containers for fuel storage and feeding.

Bruce: Let's ask Mr. Acorn, who is currently producing chips in that area. What do you think about container trucks? What is the likelihood that you will have one?

Mr. Acorn: I would hate to get a container truck. I am happy with the system we have got going now. I don't see why we would use another.

Bruce: If we cannot get fuel into a bin that will go inside the existing storage room, I think our costs will be too high.

NOTE: A lengthly discussion followed concerning the delivery of fuel into the existing fuel storage area.

Erik: If it was up to me, I would go manual feeding for one year. After one year you will see what you can do.

Bruce: You will still have the problem of getting the fuel into the fuel storage area don't you?

Erik: Yes, but it is best to wait and there are a hundred things you can do, things that can solve the problem.

Bruce: My assumption for this and various other sites was that there would be a vehicle that could deliver to above-ground fuel bins. We will have to

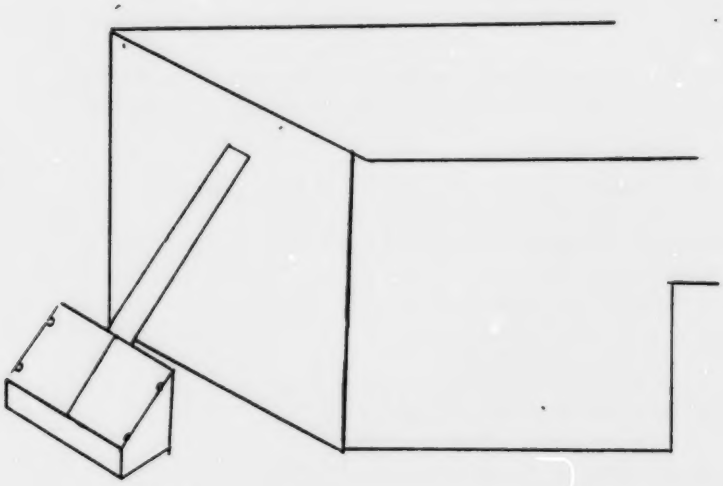
reconsider the whole question of fuel storage if we do not have access to such a vehicle.

Comment: I know you have in-ground bins, but you also need above-ground bins or containers. I think you would have to look seriously at a delivery method which can deliver to above-ground. If you are going to have a complete picture you need something that will deliver to above-ground bins.

Bruce: Yes, it would help a lot. It would make things a lot easier.

Wednesday May 27, 1987

Ian: We left off yesterday on our discussion on the Iceland Arena. Art very kindly prepared a sketch, showing the system that he had in mind, and perhaps Art would like to explain it.



Art: All I have done here is put in an above-ground receptacle or hopper. You accept chips from a dump truck into a trough and then have an escalator running right into the top of the storage bin, or the existing storage building. At the top of that escalator we could put a grain distributor or fertilizer distributor which would give you an even distribution of chips throughout the whole bin. Eldon has even gone ahead and done a cost estimate on that; the total cost of that system installed would be about $3,000.

NOTE: Another lengthly discussion followed on different methods to get chips into the arena storage building and how to distribute them within the bin.

West Royalty Gardens

Bruce: It is a pretty tight spot. I thought it was a real challenge. I am interested to hear what Erik Gunnarsson has to say about it. Although the capacity of the boiler is 430,000 BTUs I am not sure they really need that much on a continuous basis. I think any 100 kw system or close to that would probably do the job.

The first suggestion was a 100 kw TP stoker going into the front of the boiler. We have not seen the 100 kw unit here as yet, but it exists. We have a price on it, and I made the assumption that it would work having seen the 50 kw. It would be a fairly simple and inexpensive installation. Manual feed with a small escalator as we have discussed previously would keep the costs down fairly well. It would be a pretty reasonable installation in my opinion. It would certainly offer them a much greater degree of convenience than they have now.

The second choice was a Danish Twin Heat, 90 kw stoker with remote fuel bin. Twin Heat have very interesting systems. I have never actually seen one of their chip burners, but Dave has?

Dave: Yes. I have seen the 90 kw. They pride themselves on testing things very thoroughly and developing them. So they seem to be very good, engineering wise.

Bruce: The third option was a Vallsta 150kw , and with remote fuel bin. Vallsta use a wheel system very much akin to the one that Dave Murray described the other night. And for the larger systems you generally buy just the burner head and auger and wheel, and build the bin up as you wish. The question of course is the placing of these items. Whether you would put it down in the lower portion of the boiler room, and simply feed the bins with something like a snow scoop or whether you would make the bin more remote and completely automated. If you were to use the Swebo, I would suggest that you put a port in the side of the boiler and go in 90° to the fuel bin.

Art: This is an ideal situation to put in a package unit.

Tony: Yes, put a package right in where all the wood was piled. This could get around all the fuel handling problems and all the limited access problems.

Bruce: To move that boiler room your dollar costs are going to really go through the roof. You are going to go from $7-8,000 up to $30,000 right away.

Ian: I think there is another thing to keep in mind. We are trying to discuss how we would retrofit this unit. If the main project goes ahead, we will then look over all these potential installation sites and new ones that will likely come in through the newspaper ads. There maybe new sites that are more attractive.

Charles: He already has a difficult fuel to burn. Any stoker he would install would be a big improvement.

Bruce: I would like to have some comments from Erik and Bjorn perhaps. You had a specific idea for that site. Could you maybe tell us what that was?

Erik: Perhaps we can put a Swebo beside the boiler and an EGAB bin along the outside wall.

Bruce: Do you feel that a truck could dump into a ten-foot feeder bin? You would put it down in the ground?

Erik: No. You do not go down into the ground; I thought he had a tractor. He did not have that?

Bruce: No, he did not.

Art: There is another alternative here. We are back in town now and we probably should be thinking about containers again. Put your boilerroom on the slope so that you feed directly out of the container into the burner.

Charles: He is already doing quite a bit of manual work. I think a greenhouse operator will cut corners and do more manual work than a lot of other people. I don't think these guys are looking for a completely automated system.

James Allen's Pig Farm

Bruce: The current consumption is heading towards 200 tonnes of chips-a-year equivalent. They have a roughly half-million BTU Belmont boiler with 1,000 gallons of water storage. In my opinion they are pushing roundwood as far as you can go. Expansion of the heat load would be questionable. Chips would offer much higher efficiency and convenience. The furnace building has a fair amount of room for additional equipment but not for storage. You can retrofit that boiler, over Bjorns' protestations, but it can be done at a fairly low cost relative to the size of the system. They would require a chip storage facility of some kind. The farmer has indicated that he would be responsible for a building.

Vince: He also wants to burn some roundwood; he is under a forestry program and he has many cords of roundwood which he wants to use as a back-up.

Art: I think that the Swebo Flis would probably work alright here and I think that Bruce's recommendations, either one of them would be valid.

Bruce: I recall being raked over the coals about these manure spreader bins. Do we want to use them for fuel storage and feeding? Perhaps you could speak to that just briefly, Eldon; you have had some experience with them.

Eldon: I saw a couple of those in use in Finland. They just put the unit against where the auger came off the back; put a hydraulic motor on the front and run it off the hydraulics. It worked well.

Nazmir: I think you will be breaking a lot of chains.

Art: You shouldn't, Nazmir, because the density of the material that it was originally designed for is much greater than that of wood chips.

Tony: Yes, but the volume is a lot less, you are extending the sides here vertically to perhaps 8 feet.

Bruce: My only concern is the way the chips fall into the auger; I think that you might have to play with that a little to get it to come out properly.

Tony: That is not a problem, thinking specifically of Lloyd Brown's installation up in Newcastle. The chips move into the cross auger, and the cross auger takes them away.

NOTE: Futher discussion followed on the type and durability of the chain and the power requirements to drive it. Questions were raised about its long-term durability.

Bruce: The original concept was to feed a Swebo bin with an auger from the spreader. However, you could turn it 90°.

Ian Flann: You are just backing the manure spreader up against the top edge of the Swebo bin and dumping into it.

Bruce: Yes, you get away from the screw auger and also the small hatch at the end of the bin. So you are going directly into a bin that is two metres wide and 1.35 metres deep.

Tony: If you go that route you want to pay additional attention to fire protection. You have a water deluge system in the Swebo anyway, I think.

Bjorn: Yes.

Ian Flann: You are still using a front-end loader to fill it aren't you?

Bruce: Yes.

Vince: I think it would be more attractive for other installations later if the spreader was mobile. You can also use it to transport chips from the woods to the storage building.

Ian Flann: It is $4,000 for your spreader, is that the figure you use? Okay, so we can afford to have two, one that's parked there and one being loaded someplace, so we always have one loaded one for surge capacity; when the first one gets empty you just have to change it.

Art: There are a number of advantages to keeping this thing simple and using this type of equipment. First of all the farmer knows it, he has used it, he can fix it and if it doesn't do the job he can use it as a manure spreader.

Linden Lee Farms

Bruce: I think people there probably understand the situation. They have an 80 kw system which turned out to be smaller than what they needed. They would like to heat an additional barn and also do more grain drying. So they want a system that is more than double what they have now. That would lead them into something like a 250kw Swebo, or if you were talking about a stoker, something like a 300 kw Vallsta. In my recommended options I was looking at a new boiler and the 250 Swebo chip burner with the 4-cubic-metre bin that would be filled twice a day by his front-end loader which he already has in operation at the site. And, as a second option, basically the same boiler and burner but

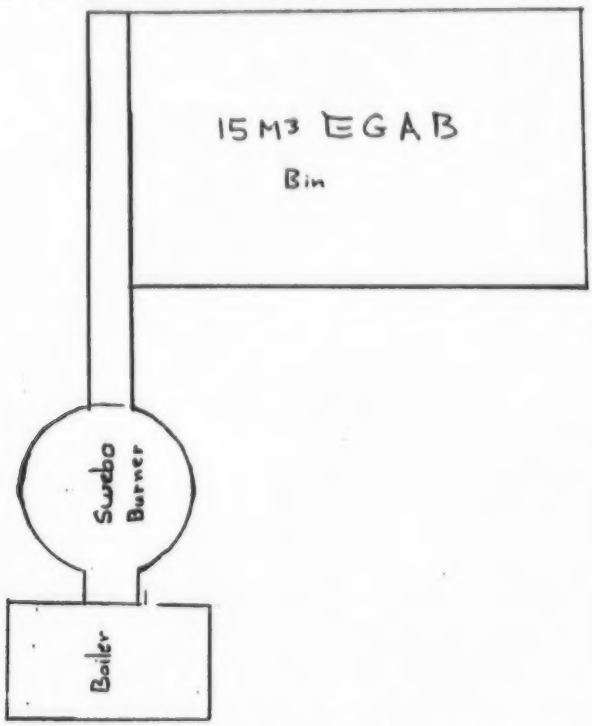
going to a remote EGAB fuel bin or it could be a number of other remote bins such as Vallsta.

Marc: If you wanted a new site to try out Nazmir's bin unloader, this is a nice one. This would be a good one because the guy is so mechanical.

Tony: It seems an artifical application for that feeder; I don't think that you need it there. I think that with the storage that he has got and the equipment that he has got, filling the bin once a day with a front-end loader would be very quick and very efficient. You would be using one more piece of equipment to demonstrate another piece of equipment, not because there is a real need for it.

Bruce: Perhaps you could have an EGAB at 45° to the boiler. Can you do that Bjorn?

Bjorn: Yes, you can go into the Swebo bin or directly into the burner.



Bruce: How many cubic metres would that give you?

Erik: You would have 15 cubic metres.

Vince: That would be approximately a day and a half.

Bruce: Is there any preference between a 4-cubic-metre bin and an EGAB bin?

Eldon: I kind of like the EGAB bin myself.

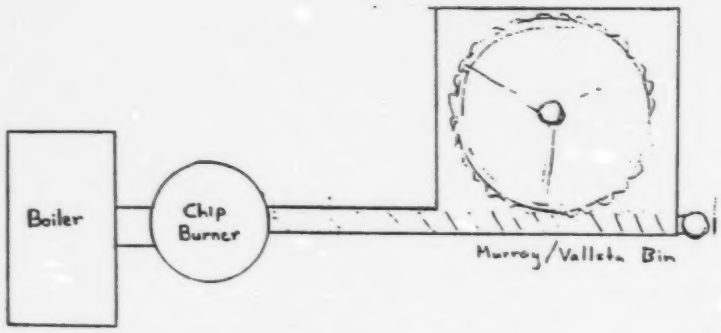
Tony: I would opt for the 4-cubic-metre bin. He has a big front-end loader and a big load of chips and it is a relatively minor operation to take a couple of

scoops and fill up a 4-cubic-metre bin once in the morning and once in the afternoon; he is travelling around in that vicinity anyway. Why spend a lot of money on a bin when you don't really need one.

Ian Flann: Why use the EGAB rather than a Belarus? Is the EGAB more suited to this than the Belarus?

Tony: Well I think that that is one of the fundamental discussions that we have had over the last couple of evenings or so to the effect that the Belarus was designed for one particular application and we are applying it to something quite different where it may or may not work. Let's find out. The EGAB has been designed especially for this kind of an application. So we want to take a look at two different things.

Bruce: I think that it is a valid question. It may be better to put another non-hydraulic bin here, for instance Dave Murray's Vallsta-type bin.



Integrated Aquatic Systems Ltd.

Bruce: You probably all recall this installation. It has a 130 kw Saturn chip or sawdust burner, which is currently fed with a wheelbarrow 3 or 4 times a day. He would like to go to something that could be loaded with a front-end loader. I suggest that, if we are looking for a physical site to accommodate Nazmir's NCF system, this might be it, just by virtue of the layout of the site. In addition the owner, Wayne Van Touver is very good technically and the unit can be fed manually if the feed system breaks down, as it could, being a prototype.

Ian Flann: It is an unfair question, Nazmir, but what would it cost for your rig to feed the Saturn boiler?

Nazmir: Actually I was looking at the site myself. We could retrofit the existing plywood bin with the new system with very little expense.

NOTE: A lengthly discussion followed regarding a longitudinal or latitudinal orientation of the fuel bin.

Subsequently, EMR arranged a small contract for the fabrication and installation of a NCF at this site.

QUEEN'S ARMS MOTEL

Bruce: Apparently there is a planned expansion (from a one-story motel to two stories) according to Mr. Shalabi who is the engineer for the owner. That would increase consumption up to the range of 180 tonnes. That would require perhaps a 200 kw burner. I had suggested a package system as one option. Another was to put a new boiler room in the basement. I think it is an application where you could use container feed, one container. Have the boiler in the basement. Either Goran Stadighs' system or the type that Dave Murray was suggesting. Or you could go to a remote package such as a Ran Heat or Vallsta.

Tony: How have you priced this? Are these quotes from Ran Heat?

Bruce: Yes. This was based on a Ran Heat price from last October. Ran Heat, as I said, do specialize in these types of things. When I was there they made a presentation on a system in the north of Denmark. They started in the morning, loaded it on a truck, drove it 200 kilometres and then installed it and were back home by 6:30 pm.

Tony: It sounds impressive. It seems to me that this is the type of technology that should be demonstrated because there are a number of applications that could benefit.

Ian Flann: In response to what you said, I said that the economics were not an important factor at the present time and I gave the reasons. But we do have a few problems; the project isn't even approved yet and it is a large chunk of money for a package system for a small-commercial application. There are probably far more applications for other types of equipment that we have looked at, rather than a package unit.

Bruce: I would like to hear Eldon on this? You were quite keen on pre-fabricated systems?

Eldon: As far as I am concerned that is the way we should do it. Especially for motels. The liability insurance drops 30% if you sit that thing 100 feet away.

Art: This is the sort of thing which I would have recommended strongly for the MacLaren Building site in Montague.

Dave: This could be a site for my containers. When the development work is complete the price should drop to about $5,000.

Bruce: Perhaps we could go to Goran Stadigh's system with the boiler installed in a new boiler room. What would be the container system cost there?

Goran: Well, it would cost 350,000 Swedish Krowns, which is approx. $50,000. But while studying these problems and thinking about it, I think it is possible to design a new container that contains about 15 cubic metres. It should have double wheels and could to be pulled around like a normal trailer. I think a complete system with one conveyor would cost $20,000 to $25,000. This system with the trailer could also be used by farmers who have their own fuel supply, when the distance is very short.

Vince: If we had central stockpiling, someone could take his own trailer and get it filled up and bring it back.

NOTE: Further discussion followed on details of the trailer.

Vince: There is one thing Mr. Acorn and I talked about the other day. Mr. Acorn is a chip supplier. We have to have a certain volume to make it economical for him. Otherwise the cost per tonne goes up significantly.

Bruce: This is certainly true, but we are into this dilemma of putting a large, high-priced fuel bin into a small demand system or alternatively matching the fuel bin to the size of the load, and bringing your costs down, and then having to pay higher fuel cost because you taking fuel in lesser quantities.

Mr. Acorn: We do it for $25-30 a tonne in the Montague area. We deliver a 14-tonne load.

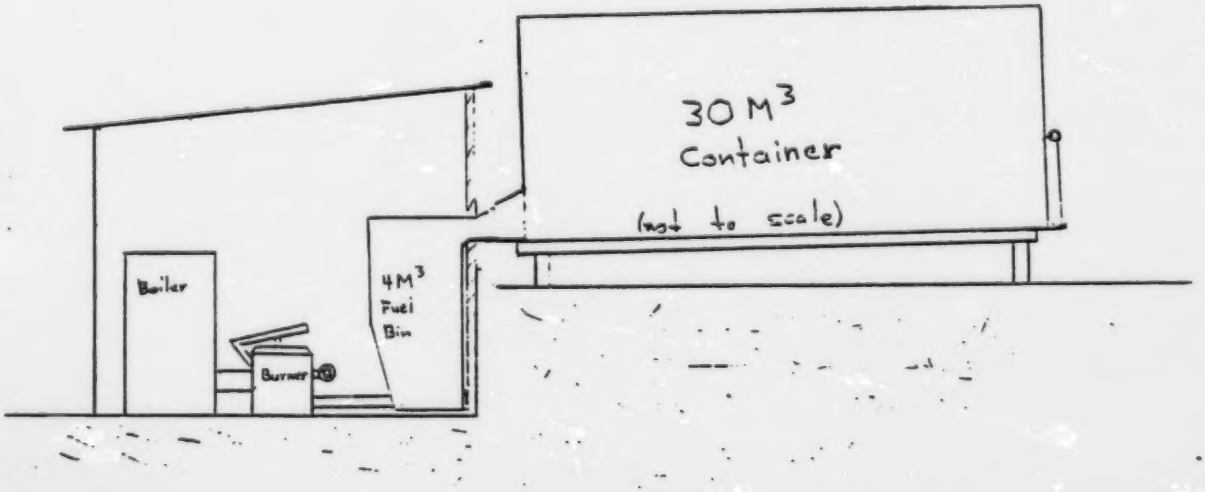
Bruce: This really just brings us back to the issue of the delivery system, both the technology and the delivery contractor. I am not sure we can really ever solve that. We seem to be working against those two issues: keeping the costs of the system down which increases the cost of the delivery, more frequent deliveries and higher cost, or having the large fuel bins which will take fuel at a minimum cost but have a high capital cost.

Eldon: Responsibility for fuel delivery development was given to the provincial government wasn't it?

Bruce: Yes, under the Alternate Energy Development Agreement.

FINAL SESSION

Bruce: I have a configuration that I wish to get some comment on. A lot of schools have below-grade boiler rooms. I was wondering if you could use a container and feed directly into a 4-cubic-metre Swebo bin. The point that I am making here is that you have only the cost of the container and you also have a 4-cubic-metre hopper so when the container is empty you have 6 or 7 hours in which to replace the empty container with a full one. You have minimal capital costs. This would only work in a situation where you have a below-grade site.



Ian Flann: So instead of dumping into a cross conveyor, you are in effect dumping into the top of a feed hopper.

Bruce: Yes, the point being that the cross auger costs money and if the site is suitable you could reduce that considerably.

Goran: Yes, this is possible.

Ian Flann: I understand that there are a number of general issues that various participants want to discuss. Who wants to lead off?

Tony: The definition of R & D topics for the whole business: fuel chip harvesting; handling on sites; Goran's comments on flexible augers; concerns that we have heard relative to the economics of trucking small loads of chips versus the need for small, low-cost installations; how to get fuel off the truck and into the above-ground bins. There are just loads of problems.

Ian Flann: Tony, we need to make up a list like that.

Eldon: I would like a cost estimate on fuel delivered in Sweden, how much do the chips cost?

Goran: The cost of wood fuel chips in Sweden is $20.00 per cubic metre.

Bruce: I use a figure of about 4 cubic metres per tonne. Would you agree with that?

Eldon: That's $80 per tonne and here we are trying to supply chips for $20 - 30 per tonne. If Mr. Acorn could get that per tonne he wouldn't mind hauling small loads.

Goran: That is good because then the installation costs can be a little higher.

Tony: How much use is made of chip dryers or is any attention being paid to drying chips in Sweden, commercially?

Goran: Not as far as I know but there has been a lot of testing.

Bruce: What is a typical moisture content?

Goran: Well typical moisture content when you are chipping green wood, is about 40% or 50% and the other way is to take the roundwood out of the woods, pile it beside the road, dry it and then when you chip it the moisture content will be about 30%.

Tony: Would it be correct to say that, in small capacity installations where the chips may be in storage for some time, months, it is routine to use an air-duct system or some fan for drying chips or is this not always done?

Erik: Yes, many of my customers do this; they have little ducts in the middle of the stack of chips and blow air into them.

Bjorn: If you have a building for chips and you put a fan in a tube, you can dry them in one-half day when we have good weather. It is very good economy to do that.

Bruce: I might say that in Finland, where I went last fall, small-commercial system drying was very common. In fact, I would say that it was the rule rather than the exception. This was mainly farmers; they did it in their own fuel storage buildings, using very simple aeration tunnels, and agricultural fans.

Bruce: I have a final question on chip fuel. You don't measure the moisture content, I believe; you buy chips by the cubic metre do you not?

Goran: No, you don't; you make an agreement with the owner of the boiler plant and you measure the energy output from the boilers.

Tony: By contrast at the University of New Brunswick, when fuel is delivered, plant operating personnel take 3 or 4 samples per truck to determine the moisture content and the trucks are weighed.

Dave: One of the things I haven't heard addressed is establishing priorities, what work really needs to be done. I was thinking about equipment like pre-heaters, stokers, etc., wood handling mechanisms, delivery mechanisms. I'm afraid that some of these things will get left out or that some will be included when they shouldn't be. You know what I mean; ensure that the money reaches all the areas that it should reach. We don't all want pre-heaters or we don't all want stoker burners.

Bruce: That is a good point; maybe we could have a three or four minute discussion on what people think should be included and where our priorities should lie.

Vince: I don't think that we should have to import all our boilers. We should attempt to find two or three good Canadian boilers.

Ian Flann: It means testing all the existing boilers with a standard heat source, if such a thing is possible, trying to sort out all of them, the good ones and the bad ones, etc. It is a real problem.

Vince: I think that I was more saying that we should be looking at boilers that have been produced in the Maritimes like the New Yorker. It would be great if we could identify two or three good boilers.

Ian Flann: How do you do that without offending someone?

Bruce: Well let me rephrase my original question. Are there items that people feel should be tested out of the various ones that we have discussed over the last few days and are there items that you would particularly like to see discarded. We have been through a shopping list in a sense, through the various site proposals.

Dave: The container system that I have worked on has been suggested as an option on one of the sites. The question really comes down to whether it is really even a good idea to build and test that system or not.

Bruce: I am asking you to advise us.

Dave: I want to raise a question, pre-heaters have been suggested and then some suggested stokers. Should we have an equal number? What is the exact distribution, I think we should decide on that.

Ian Flann: No, EMR will choose certain pieces of equipment that we want to test. But we don't want to force a piece of equipment on a site.

Vince: One of the things that I was wondering about at noon was whether, for a 250 kw installation, it would be more cost effective to install two 130's with 4- cubic-metre bins or a single 250 kw unit with, say, an EGAB fuel bin?

Bruce: It would cost roughly $14,000 for option one and $22,000 for option two, the difference being 8 cubic metres for option one and 15 cubic metre for option two. Those two 4-cubic-metre bins are each two metres wide. Do you have the space to install two 4-cubic-metre systems beside one boiler.

Bjorn: You must have two boilers unless they go on different sides.

Bruce: I would like to come back to the question of prefabricated heating plants.

Art: My personal feeling is that containerized system is an item that has a place in a site where you can put in the system in a very short time.

Tony: I think if there were a contract for one of the sites, local consultants and fabricators could assemble the package here. I think that they could be cheap.

Bruce: Is there any possibility that someone like Eldon could get together with Bjorn and Erik and produce a package unit?

Tony: The package concept is rapidly advancing; just as mobile homes are standardized, package units should offer standardization.

Vince: Will the contractors select the equipment?

Ian Flann: The contractor isn't going to have to select anything. If the project is approved, EMR will select the equipment and we will ask him to bid on the cost of installation and maintaining it. It will be up to the people that make the selection to spell that out in the RFP. I would like to go back to Tony's request for a list of R & D projects. I will start the list with flexible chip conveyors.

Bruce: I would like to add an unloading device that can attach to existing dump vehicles, be they containers or dump trucks, that could unload fuel rapidly, and deliver fuel to an above-ground fuel bin.

NOTE: A discussion followed about the difficulties of measuring volumes of partial loads delivered to a site.

Ian Flann: Okay any other ideas, any other items for R & D?

Dave: We should maybe look at the economics of different delivery container systems, self un-loading and so on.

Tony: Maybe it is worth going through this whole business of engineering and economic anaylsis on small bin deliveries in the P.E.I. context.

Bruce: I would like to see a serious look at true stokers versus pre-heaters and the implications for boilers, their modificiation, etc.

Bjorn: We have talked about everything here but it is good if you send P.E.I. equipment dealers over to Sweden. We can take them out to many places and give them information on many things. They can see many chip systems. They can visit Goran and Erik and me. It is not a waste of money. We must educate the people that work with their hands.

Bruce: I am hopeful that if we do go ahead with some systems from Goran Stadigh or Swebo Flis or EGAB, they or people who work for them will come back and work on the installation and train people here in the process for both the installation and maintenance. These systems must be working perfectly before they go home.

Ian Flann: I would like to thank all the participants for their input. I hope that we can get together again next year to review progress and plan further advances.